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Application of Morphology on Detecting Edge of Smart Grid Image

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Abstract

In the construction of intelligent substation system, In this paper, method based on morphology is put forward to detect image edge.It can not only filter noise effectively but also keep the original details. The paper at last gives the conclusion. that the fittest way should be chosen when detecting edge of smart grid image.

Keywords: smart grid; morphology; edge detection;image quality; filter noise

1.Introduction

The fundamental goal of power system management is to guarantee safe,steady, reliable running of power supply system.In unmanned substations,remote monitorings monitor and record the station's safety and equipment operation, and provide analysis of the relevant images afterwards. Smart Grid[1-3]is the inevitable trend of power system development. In the construction of intelligent substation system, higher quality is needed for image provided by remote monitoring system to guarantee more clearer image and edge. Mathematical morphology[4-5]on the signal processing has the intuitive simplicity and mathematical rigor on signal processing, which is a unique advantage in describing the morphological characteristics of the signal. It can not only filter noise effectively but also keep the original details. So it's a major breakthrough to use mathematical morphology on edge detection[6-7].

2.Image Preprocessing

In the edge detection process, in order to extract the image edge more accurately, not only noise suppression, but also avoiding mistaking unnecessary edge information for a target edge is needed. Therefore, image preprocessing is very important for image edge extraction.

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General picture is true color images, but the object of image pre-processing is usually grayscale or binary image.So, the first thing of detecting edge is to convert true color image to grayscale or binary one, then image denoising, contrast enhancement are done to assure edge extraction facilitatly and accuratly.

2.1.Image Denoising

The image gets many interference factors when it is taken from outside. Image denoising is necessary during the edge extraction.Figure 1 (this is a 2-column figure,shown in the last page)shows that a true color image converts to a grayscale one and filters the noise of the grayscale image. Obviously,the image and its outline are more clearly than before after denoising,which is conducive to extract edge information.

2.2.Generating Binary Image

Binary image is a logical categories, including two values 0 and 1,displayed as white pixels 0, black ones 1. Morphological image processing is usually expressed as a form of field operations.It defines an area known as "structural elements". In the pixel location, the structural elements and the region corresponding to the binary image make specific logic operations, from which can determine which pixels are the boundary ones. Therefore, the direct handling objects are binary image in morphology edge detection. Figure 2 shows that a grayscale color image converts to a binary one.

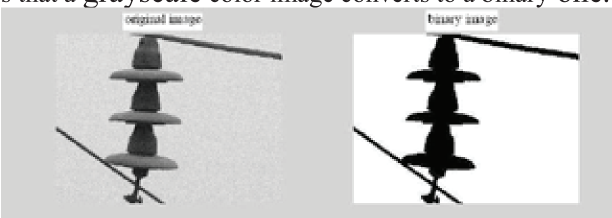

Figure 2. Grayscale Color Image Converting to a Binary One

2.3.Mathematical Morphology Processing

The image quality can be further improved by using mathematical morphology.Dilation and erosion are the most basic operations in morphology,both sensitive on the edge where gray changes much.

Dilation mergers the background points into the object, which makes the boundary expanding to the outside. This action can fill the hole in the object. Dilation is generally defined as

$$D(x,y) = (I \oplus T)(x,y) = \bigcup_{i,j=0}^{m} [(I(x+i, y+j) \,\&\, T(i,j)] \quad (1)$$

Erosion can eliminate boundary points so that the boundary contracts to the internal area. This action can remove small and meaningless objects. Erosion is generally defined as

$$E(x,y) = (I \otimes T)(x,y) = \bigcap_{i,j=0}^{m} [I(x+i, y+j) \,\&\, T(i,j)] \quad (2)$$

The process of first erosion then dilation is called open computing,defined as

$$\mathrm{OPEN}(X,B) = X_B = X \circ B = (X \otimes B) \oplus B \quad (3)$$

This operator can remove small objects, erase the burr on the outline and smooth image contours.

The process of first dilation then erosion is called close computing,defined as

$$\mathrm{CLOSE}(X,B) = X_B = X \bullet B = (X \oplus B) \otimes B \quad (4)$$

This operation can fill small holes inside the object,connect the objects near and smooth the boundary.

Because of the effect of noise, image boundaries are usually not smooth after binarization.The object has some blank generated.by noise while the background area is dotted with small noise objects. Continuous opening and closing operation can effectively improve the situation. Sometimes erosion for several times then combined with an equal number of dilation in order to produce better treatment results is needed. Open and close can respectively.remove the "peak" and "concave valley" in the image. So when using morphological operations to extract image edges the image noise,especially impulsive noise,can be removed meanwhile.

Figure 3,Figure 4,Figure 5 and Figure 6 respectively shows dilation,erosion,open and close operation.

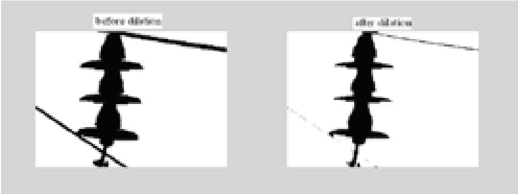

Figure 3. Comparison of Binary Image before and after dilation

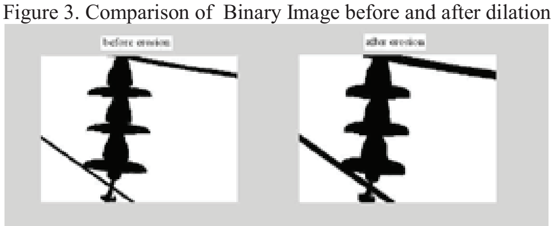

Figure 4. Comparison of Binary Image before and after erosion

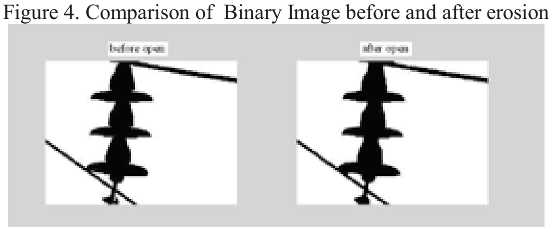

Figure 5. Comparison of Binary Image before and after Open

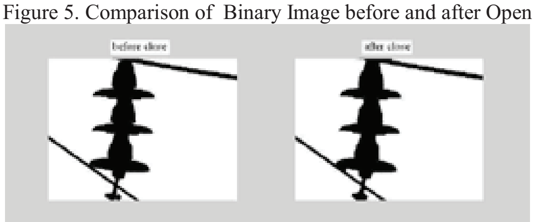

Figure 6. Comparison of Binary Image before and after Close

Generally speaking, after dilation operation, the background points are mergered into the insulator which makes the boundary expanded.But Figure 3 shows that the insulator boundary contracts inward.The reason is that the background color is darker than the insulator color. Similarly, image after erosion should be inward contraction while Figure 4 shows a expansion result. Figure 5 and Figure 6 shows that the image boundary is more smooth and uniform after opening and closing operation.

3.Example Based on Mathematical Morphology Edge Detection

After image preprocessing based on mathematical morphology,image edge detection can be carried out. Figure 7 shows the result of edge detection for Figure 6.

Figure 7. Example Based on Mathematical Morphology Edge Detection

4.Conclusion

Morphology can simplify image data,maintain their basic shape characteristics and remove irrelevant structure. The edge it extracts is relatively smooth. Its algorithm has a natural parallel structure and achieves morphological analysis and processing algorithms in parallel, which greatly improves the speed of image analysis and processing.

Of course, every edge detection operator has its applicable situation.There is no method that is applicable to all images. When doing edge detection in smart grid, the fittest method should be chosen according to the characteristics of electrical equipment image.

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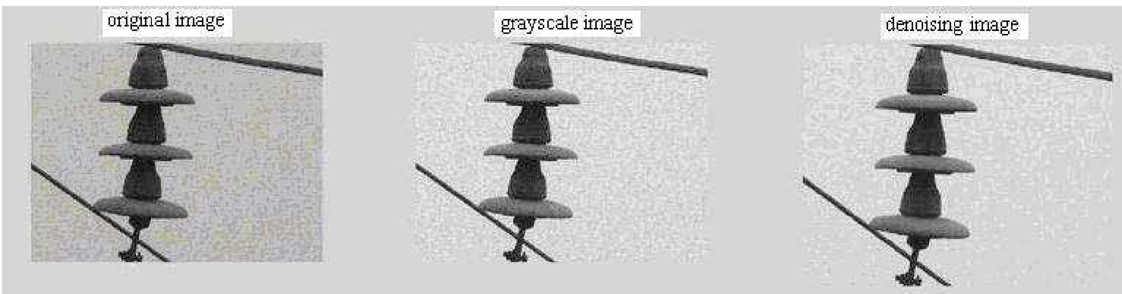

Figure 1. True color Image Converting to a Grayscale One and Filtering Noise of the Grayscale Image